Chapter 3: Rivers and Streams Water Quality Characterization

3.1 Water Quality Characterization

There are 8,020 miles of rivers, streams, canals in New Jersey. Of these, 6,500 miles (69%) are non-tidal rivers and streams, 1,520 miles (18%) are tidal rivers and streams, 1,235 miles (13%) are canals and ditches, and 197 river miles share a border with a neighboring state.

New Jersey's rivers and streams are used as water supplies for drinking water, industry and agriculture, trout and warm-water fisheries, recreation (e.g., boating, swimming) and wastewater disposal. Often, NJ rivers and streams are used for multiple purposes in close proximity.

The characterization that follows describes water quality in freshwater, non-tidal rivers and streams. Water quality status and trends with respect to Surface Water Quality Standards, and attainment of designated uses for aquatic life, recreation, drinking water, agriculture and industry.

Designated use attainment for tidal waters is discussed in Chapter 5, Estuary and Coastal Assessment. Wetlands are discussed in Chapter 6 and fish and shellfish consumption designated uses are discussed in Chapter 7, Public Health and Aquatic Life Concerns.

3.1.1 Surface Water Quality Standards

Water quality is evaluated with respect to Surface Water Quality Standards (SWQS) and water quality issues or concerns occur when SWQS are not met or are threatened. New Jersey s Surface Water Quality Standards (N.J.A.C.7:9B) establish the water quality goals and policies underlying the management of the state s water quality. These standards designate the use or uses of the water and establish policies and narrative and numerical criteria necessary to protect the uses. SWQS are explained below.

Water Quality Goals: National water quality goals were established in the Federal Clean Water Act. These goals state that surface waters should be fishable, swimmable and potable (after reasonable treatment). The national goals are reflected in the designated uses of waters established in New Jersey s Surface Water Quality Standards (SWQS) and the water goal statement developed under the National Environmental Performance Partnership Agreement (NEPPS).

Clean and Plentiful Water Goal: New Jersey's rivers, lakes and coastal waters will be fishable, swimmable and support healthy ecosystems. Surface and ground water will be clean sources of water. Every person in New Jersey will have safe drinking water. Adequate quantities of surface and ground water will be available for all needed uses.

Designated uses: The designated uses in freshwaters are: primary and secondary contact recreation (i.e., swimmable); maintenance, migration and propagation of the natural and established biota (i.e., fishable), agricultural and industrial water supply, and public potable water supply, after such treatment as required by law or regulation (i.e., potable). These uses

were established based on physical, chemical, biological, and hydrological characteristics of the waters and the economic considerations related to attaining various uses. Designated uses that apply in NJ are listed in the SWQS and are evaluated periodically. Designated uses in estuarine and coastal waters include primary and secondary contact recreation (i.e., swimmable); maintenance, migration and propagation of the natural and established biota (i.e., fishable) ; and shellfish harvesting.

Water Classifications: Surface waters are grouped into classifications as follows:

FW1: Fresh Water 1: Fresh surface waters that are to be maintained in their natural state and not subjected to man-made wastewater discharges or increases from runoff from anthropogenic activities.

FW2: Fresh Water 2: General fresh surface water classification applied to fresh waters that are not FW1 or Pinelands Waters.

FW- TP: Fresh Water - Trout Production waters are designated for trout spawning/nursery during their first year.

FW- TM: Fresh Water - Trout Maintenance waters are designated for the support of trout throughout the year.

FW- NT: Fresh Water - Non Trout: fresh surface waters that have not been designated TM or TP. These waters are generally unsuitable for trout because of their physical, chemical, or biological species, but are suitable for a wide variety of other fish species.

PL: Pinelands Waters: all waters within the boundaries of the Pinelands Area, except those designated as FW1.

SE: Saline Estuarine: general surface water classification applied to saline estuarine waters (salinity greater than 3.5 parts per thousand at mean high tide)

SC: Saline Coastal: general surface water classification applied to saline coastal waters

ND: Nondegradation waters are waters set aside for posterity because of their clarity, color, scenic setting, other characteristic of aesthetic value, unique ecological significance, or exceptional water supply significance. These include all waters designated as FW1 in this report.

C1: Category 1 waters are designated for implementation of antidegradation policies for protection from any measurable change in water quality. C1 may be applied to any surface water classification except those designated as FW1 or PL. Note: the Department is currently proposing a clarification between the definition of ND and C1 antidegradation policies

C2: Category 2 waters are waters that are not designated as Outstanding Natural Resource Water (i.e., FW1 or PL) or C1 for implementation of antidegradation policies.

Water Quality Policies: Anti-degradation policies apply to all surface waters of the State. Existing uses must be either maintained or protected, and no irreversible changes to water quality are allowed that would impair or preclude attainment of designated uses. Waters classified as nondegradation waters (i.e., FW1) must be maintained in their natural state, and are not to be subject to any manmade wastewater discharges. Narrative criteria that prohibit changes in natural water quality apply to high quality waters. Water quality characteristics that do not meet criteria must be improved to meet criteria.

Water Quality Criteria: States are required to adopt water quality criteria that will protect both the existing and designated uses of a waterbody with an adequate degree of safety. Numerical criteria are often established for chemical pollutants, sanitary quality, and physical characteristics of the water such as temperature and dissolved oxygen. Narrative criteria that prohibit toxicity in surface waters are established to protect against the effects of multiple pollutants. A summary of SWQS criteria is provided in Table A3.1.1-1 in the Appendix**.**

3.1.2 Water Quality Data Collection and Characterization

This water quality characterization provides comparisons to Surface Water Quality Standards criteria and trends over time. SWQS criteria were developed to protect a variety of designated uses in surface waters. These results provide a useful indicator of designated use attainment, but must be supported with other types of data (e.g., biological data) to comprehensively evaluate use attainment status. Currently, NJDEP is developing a method to formulate a "fishable index" that includes water quality, fish, benthic and eventually algal data. For this 2000 Water Quality Inventory Report, this water quality characterization is intended to provide useful information regarding status and trends in water quality, but is indirectly related to designated uses.

Water quality data for this characterization were collected from non-tidal rivers and streams between January, 1995 and December, 1997 through the 81 station Ambient Stream Monitoring Network (ASMN) shown in Figure 3.1.2-1. Table A3.1.2-1 in the Appendix provides a list of stations and stream classifications. The 1995-97 time period was chosen for this characterization because data collected prior to 1995 were described in the 1996 and 1998 NJ Water Quality Inventory Reports and the implementation of the redesigned Ambient Stream Monitoring Network began in October, 1997. Only 1998 data had been published by USGS at the time this report was written. In addition, work has not been completed on a project with Rutgers University to develop a data analysis guidance manual to ensure appropriate statistical analyses of the data collected in the new design. Thus, the assessment of data from the redesigned ASMN has been deferred until the 2002 Water Quality Inventory Report.

The redesigned Ambient Stream Monitoring Network provides data from 5 station types (background, land use indicator, watershed integrator, statewide status and synoptic). This design was intended to provide water quality data from a wide variety of stream characteristics and significantly expand the number of stream miles monitored by providing a strong statistical

basis for estimating water quality in streams with similar characteristics that are not monitored. A project funded by EPA is ongoing to identify the appropriate statistical techniques to apply to this dataset. Thus, data characterizations from this network will be provided in subsequent NJ Water Quality Inventory Reports. The redesigned ASMN is described in more detail in Appendix A3.1.2-2.

The ASMN has been operated cooperatively since the early 1970's by the NJDEP and USGS. Since this network was described in previous New Jersey Water Quality Inventory Reports, a brief overview is provided here.

Water quality samples were collected quarterly at 81 stations in freshwater, non-tidal streams and rivers using cross-sectional depth-integrated sample collection techniques. Concurrent measurement of stream discharge was also collected. Samples were sent to either the New Jersey Department of Health and Senior Services (NJDHSS) certified laboratory or the USGS National Laboratory in Denver for analysis. Laboratory results were thoroughly reviewed for quality assurance purposes and managed in EPA's STORET database. Raw data were reported by USGS in Water Year Reports. (USGS, 1995, 1996, 1997). Electronic data are available to be downloaded from EPA's STORET database at www.epa.gov/owow/STORET. Water quality parameters are provided below in Table 3.1.2-1

Table 3.1.2-1: Routine Water Quality Parameters

Date/ Time	Calcium	Nitrite
Instantaneous discharge	Magnesium	Nitrate + Nitrite
Specific conductivity	Sodium	Ammonia - total
pH	Potassium	Ammonia - dissolved
Water temperature	ANC Unfiltered	Ammonia + organic N -total
Barometric pressure	Sulfate	Ammonia + organic N - dis
Dissolved oxygen	Chloride	Total Nitrogen
DO % saturation (calculated)	Fluoride	Dissolved Nitrogen
BOD (5 day)	Silica	Total Phosphorus
Fecal Coliform	Solids (residue)	Dissolved Phosphorus
Enterococcus	Solids (calculated)	Dissolved Organic Carbon
Hardness	Residue at 105 C	Suspended Organic Carbon

Supplemental water column parameters are collected 2 times per year at 1/3 of the stations on a rotating schedule. Thus, all stations are sampled over 3 years. Parameters include:

Table 3.1.2-2: Supplemental Water Quality Parameters

Chemical oxygen demand	Arsenic	Beryllium
Boron	Cadmium	Chromium
Copper	Iron	Lead
Manganese	Mercury	Nickel
Selenium	Zinc	

Supplemental sediment parameters include metals, organic pesticides, herbicides and PCBs.

Under contract to NJDEP, USGS conducted a project to characterize water quality status and trends in NJ between 1986 and 1995. (USGS, 1999). The results were used in the characterizations that follow to summarize trends.

Characterization Method: Water quality data characterizations were conducted for a subset of water quality parameters through a project to improve water quality indicators. A subset of the routine parameters in Table 3.1.2-1 that are important to water quality characterization and TMDL planning were selected. Water quality data were compared to applicable NJ Surface Water Quality Standards (N.J.A.C. 7:9B) described in Section 3.1.1.

Metals were not included in this characterization. The metals monitoring in the ASMN includes only total recoverable metals. Many of the aquatic life criteria currently adopted in the SWQS are based on dissolved metals, so direct comparison to dissolved aquatic life criteria is precluded by lack of data. Since 1995, the Department and USGS have instituted improved sample collection and analysis procedures to avoid inadvertent sample contamination.

Given these concerns, NJDEP, with assistance from USGS, began the "303d Evaluation Monitoring" project to assess current levels of metals in streams included on the 1998 Impaired Waterbodies List. This project includes collection total recoverable and dissolved metals data, which are needed for comparison to both human health and aquatic life criteria. Stringent quality assurance measures in this project include the use of "Clean Methods" sampling techniques and collection of field equipment blanks. These data will be used to inform development of the 2002 Impaired Waterbodies List.

EPA Guidance for the Preparation of Water Quality Inventory Reports recommends that states consider the percent of samples exceeding applicable SWQS to identify impairments. (EPA, 1997). NJDEP applied the guidance to water quality data characterizations. EPA guidance for conventional (i.e., non-toxic) parameters is summarized on Table 3.1.2-3 below.

Table 3.1.2-3: Water Quality Data Characterization Method for Conventional Parameters

SWQS Met	Less than 10% of samples exceed applicable SWQS
SWQS Met but Threatened	Less than 10% of samples exceed applicable SWQS, but declining WQ trends indicate SWQS are likely to be exceeded in more than 10% of samples within 2 years
SWQS Partially Met	Between 11% and 25% of samples exceed applicable SWQS
SWQS Not Met	More than 25% of samples exceed applicable SWQS

Notes:
From: EPA Guidance for Preparation of Water Quality Inventory Reports, EPA, 1997.
Applicable to conventional (i.e., non-toxic) parameters

Results of a USGS study which characterized water quality trends between 1986 and 1995 were used to evaluate threats to full support. (USGS, 1999). USGS also conducted a study to evaluate

the relative contributions of constant sources (i.e., point sources and groundwater) and intermittent sources (i.e., nonpoint sources) of pollution to freshwater streams. The study included a statistical evaluation of water quality data collected in the Ambient Stream Monitoring Program. Water quality data for 20 parameters collected under high and low flow conditions were used to indicate the relative contribution or dominance of point and nonpoint sources. (USGS, 1998, 1999a, 1999b, 1999c, 1999d) Selected results are summarized in the Source and Cause Assessment Section for total phosphorus below.

Spatial Extent of Assessment: This assessment was based on data collected at 76 of 81 ASMN stations. The 5 Delaware River mainstem stations were not included because the Delaware River Basin Commission (DRBC) assesses this waterbody. (DRBC, 2000)

In previous NJ Water Quality Inventory Reports, each station was assumed to represent 5 miles of stream. For this assessment, each station was assumed to represent the stream reach that was monitored. Stream reaches have been defined by USEPA in the Reach File 3 system, which can be used on GIS. Reach File 3 (RF3) was mapped at a moderate 1:100,000 scale. Using RF3, the 76 ASMN stations represent 176of 6410 (2.7%) river miles. The RF3 reach identification number and reach length are provided in Table A3.1.2-1 in the Appendix. Using RF3 was considered an intermediate approach to the more refined spatial assessment that will be provided by the redesigned ASMN.

It is important to note that the monitoring design used to collect these data does not support extrapolating the assessment results to locations or streams that were not monitored. Streams that appeared to have the greatest impacts were prioritized in this network.

Relationship to Impaired Waterbodies List (303d): Under Section 303d of the Federal Clean Water Act, states are required to identify impaired waterbodies and publish a list of these waterbodies every 2 years. (40 CFR 130.7). New Jersey regulations for the Impaired Waterbodies List are currently found at N.J.A.C. 7:15-6. Revisions were recently proposed in Subchapter 3 with revisions to the Watershed Management Planning Rules (New Jersey Register) EPA also proposed revisions to the federal 303d and TMDL rules (Federal Register) which were recently approved by President Clinton.

Under current federal and state regulations, impaired waterbodies are those waters that do not meet applicable surface water quality standards. Water chemistry data were compared to applicable NJ SWQS and included on NJ Impaired Waterbodies Lists. Federal and state regulation requires that actions be taken to improve water quality, including development of TMDLs, and/ or implementation of more stringent point and non-point source control measures. Waterbodies must remain listed until new data show that applicable SWQS are now met or the original basis for the listing is no longer applicable (e.g., change in SWQS). As specified in federal and state regulations, the Impaired Waterbodies List is developed, proposed and adopted in a public forum.

The ASMN data have provided a primary source of information regarding impairments (i.e., exceedences of SWQS) in rivers and streams. The characterization provided below is intended to provide an overview of water quality status and trends and to inform TMDL planning. De-listing will be pursued for listed waterbodies that now meet applicable SWQS; listing will be pursued for waterbodies that currently do not meet applicable SWQS. Listing and delisting decisions will also consider data from the redesigned ASMN.

3.1.3 Water Quality Characterization

Dissolved Oxygen Water Quality Characterization

Dissolved oxygen is necessary for almost all aquatic life. Thus concentrations of dissolved oxygen (DO) in water also provide an indicator of the health of aquatic ecosystems. Between 1995 and 1997, 1259 DO measurements were collected in the ASMN. The average DO for all streams was 9.8 mg/l DO and 14 measurements (1%) did not meet SWQS. Results of the application of the use support assessment recommended by EPA are summarized in Table 3.1.3-1 below.

Table 3.1.3-1: Dissolved Oxygen Status (1995-97)

DO SWQS Status	# of Stations	% of Stations	# of Assessed River Miles	% of Assessed River Miles
SWQS Met	74	97.4%	172.7	97.9%
SWQS Met but Threatened	0	0%	0	0%
SWQS Partially Met	2	1.3%	3.7	2.1%
SWQS Not Met	0	1.3%	0	0%
Totals	76	100%	176.4	

Results for individual stations are depicted on FigureA3.1.3-1 and shown in Table A3.1.3-1 in the Appendix. Results for stations that exceeded criteria and their use support status with respect to DO are provided on Table 3.1.3-2 below.

Table 3.1.3-2: Stations with Exceedences of DO and % DO Saturation (1995-97)

WMA	Station #	Station Name	DO-#	DO-Mean (mg/l)	DO-# exc	DO-% exc	%DO-#	%DO-Mean	SWQS Attainment
6	01379000	Passaic R Nr Millington	16	6.050	4	25.0%	16	54.438	Partial
19	01466500	McDonalds Br in Lebanon Forest	7	4.429	3	42.9%	7	37.571	Full (see note)
6	01382000	Passaic R At Two Bridges	47	8.211	3	6.4%	47	79.660	Full
15	01410784	Great Egg Harbor R Nr Sicklerville	51	8.011	2	3.9%	51	74.304	Full

6	01381800	Whippany R Nr Pinebrook	15	7.687	2	13.3%	15	68.800	Partial

Notes:

- 74 of 76 stations met applicable DO criteria in 100% of measurements collected between 1995-97
- WMA: Watershed Management Area (see Figure II-1)
- Station #: USGS/ STORET station number (can be used to request data from STORET)
- DO-n: number of DO measurements collected between 1995-97
- DO-mean: average of DO measurements (mg/l DO)
- DO-# exc: number of DO measurements less than applicable SWQS
- DO % exc: percent of DO measurements less than applicable SWQS
- %DO-n: number of % DO saturation measurements calculated for 1995-97 data
- % DO-mean: average of % DO saturation measurement
- Lebanon State Forest and the Great Egg Harbor River at Sicklerville stations are located in an area dominated by ground water and low DO is a natural phenomenon, not due to pollution sources.

DO readings were taken during the day and thus do not characterize the natural diurnal DO cycle. NJDEP and USGS will be collecting diurnal DO data at about 30 locations during the summer of 2000. Selected locations included background stations in the redesigned ASMN, locations with exceedences of DO criteria and locations in WMA02 with low DO measurements that did not exceed criteria.

The % DO saturation values provide a way to account for changes in DO concentration caused by temperature and air pressure: at low temperature and high pressure, water can contain more DO. Due to lack of contact with the atmosphere, ground water has naturally low DO concentration and % DO saturation. The low % DO saturation at the Lebanon and Great Egg Harbor sites is due to the large ground water contribution to stream flow, not pollution. At the remaining locations, low % DO saturation indicates that pollution contributes to low DO.

There are several locations on the 1998 Impaired Waterbodies List for exceedences of DO where criteria are now met. This finding is consistent with historical improvements in water quality as wastewater treatment plants were upgraded and regionalized in the 1980's and early 1990's. These locations will be evaluated further to pursue de-listing as appropriate in the 2002 Impaired Waterbodies List. Considerations will include data collected after 1997, if available; diurnal DO readings and trends in DO.

Total Phosphorus Water Quality Characterization

Total phosphorus is a nutrient that has been found to be limiting in many freshwater systems. "Limiting nutrients" are present in pristine systems in very low concentrations and tend to limit the growth of aquatic algae and vegetation. Elevated nutrients can contribute to excessive primary production (i.e., growth of aquatic algae and vegetation). Waterbodies affected by excessive primary productivity are characterized by significant algae and weed growth and

episodes of low dissolved oxygen. In order to protect surface waters from excessive primary productivity, NJ SWQS include nutrient policies and criteria for total phosphorus. (See N.J.A.C. 7:9B-1.5(g) and 1.14(c)).

Between 1995 and 1997, 1265 TP measurements were collected in the ASMN. The average TP for all streams was 0.1 mg/l and 407 measurements (32.2%) did not meet SWQS. Between 1995 and 1997, 22 met SWQS criterion for TP in 100% of samples collected and 6 stations exceeded the criteria in 100% of samples collected.

Of 79 stations assessed for TP trends, statistically significant decreasing trends in concentration were found at 40 stations (50%) between 1985 and 1995. (USGS, 1999). Statistically significant trends were not found at 35 of 79 locations (44%) and a statistically significant increasing trend in concentration was found at only 1 station between 1986 and 1995. Trends ranged from 0.003 ppm per year, a very slow rate of change, to 0.096 ppm/year, and a very rapid rate of change. Results of the TP assessment are summarized below on Table 3.1.3-3. Results for individual stations are depicted on Figure A3.1.3-2 and on Table A3.1.3-2 in the Appendix. The trends assessment indicated that waters that currently fully meet TP criteria would continue to meet applicable criteria.

Table 3.1.3-3: Total Phosphorus Attainment Status (1995-97)

TP SWQS Status	# of Stations	% of Stations	# of Assessed River Miles	% of Assessed River Miles
SWQS Met	29	38.2%	67.3	38.2%
SWQS Met but Threatened	0	0%	0	0%
SWQS Partially Met	15	19.7%	24.7	14.0%
SWQS Not Met	32	42.1%	84.4	47.9%
Totals	76	100%	176.4	

Excessive primary productivity may impair aquatic life and recreational designated uses. Additional assessments are needed to identify designated use impairments due to excessive primary productivity and to evaluate the relative contributions of phosphorus, nitrate and other nutrients. Thus, it was not possible to link elevated concentrations of TP to use impairment. Some major considerations include:

- Attached periphyton is often the major location of primary productivity in streams- not free floating algae
- Nutrient cycling between water--sediments--aquatic periphyton community may result in water column nutrient measurements that are very low concentrations even though the waterbody is eutrophic (nutrients are fixed in aquatic plants and algae)
- Watershed Location is Critical: Depositional areas, wetlands, lakes, reservoirs are most prone to eutrophication, not fast flowing streams. Existing monitoring sites are not targeted to these areas.

- Season, stream flow, storm events have significant effects on primary production and nutrient limitation

Multiple lines of evidence are needed to evaluate use impairment, including biological, chemical and visual indicators. Data collection and assessment should focus on watershed locations that are susceptible to excessive primary productivity (e.g., lakes, reservoirs, wetlands, and estuaries).

- Biological Indicators of Eutrophication
  - Primary Productivity/ Total Biomass Measurements
  - Algal Biostimulation Assay
  - Periphyton Community Assessment
  - Benthic Community Assessment (i.e., dominance of filter feeders)
  - Impaired fisheries/ fish kills

- Water Chemistry Indicators of Eutrophication
  - Diurnal DO below 4 -5 mg/l
  - % DO saturation above 120%
  - TP concentration
  - Total Inorganic Nitrogen to Total Ortho-Phosphorus (TIN/TOP) ratios
  - TSS above SWQS/ depth of unconsolidated sediment
  - Elevated In-Stream BOD (biochemical oxygen demand)
  - Elevated In-Stream DOC- dissolved organic carbon and Elevated TOC- total organic carbon
  - Application of aquatic herbicides

- Visual Observation Indicators of Eutrophication
  - Nuisance aquatic weed growth
  - Invasive wetlands species
  - Stream flow (drought, water diversions may contribute to eutrophication)

In many cases, data for these indicators collected at appropriate locations are not available to evaluate use impairments associated with excessive primary productivity. However, additional data and assessments are expected to become available as TMDLs for nutrients are planned and watershed partnerships are established.

Characterization of Use Impairments Associated with Excessive Primary Productivity
As described below, significant efforts are underway to characterize primary productivity and the health of biological communities. These efforts will continue as total phosphorus TMDLs are planned.

- Algal biostimulation assays were conducted at 17 locations to identify limiting nutrients using a test algal species. Preliminary results indicate some locations are limited by

phosphorus, while others are limited by nitrate or other micronutrients (e.g., iron). Additional assays are planned.

- A periphyton study with the Academy of Natural Sciences was funded to evaluate periphyton communities in a range of locations, including pristine and disturbed watersheds.

- A watershed indicators study with USGS was funded to evaluate benthic communities using NJDEP's 820 station Ambient Biological Monitoring Network and identify factors that contribute to impairment

- Fisheries data were recently computerized and quality assurance checks are underway. This database will be used to identify impaired fisheries and can be linked to water quality data.

- Additional water quality data collection is being planned at 200 new locations, bringing the network to 300 stations. Diurnal DO data collection at locations with suspected impairment began in the summer of 2000. Additional water quality data will also be collected as needed to support development of TMDLs.

- Aquatic pesticide application locations, compounds and amounts are being put into a GIS database.

- The River Assessment Team program is encouraging stream walks by watershed partners. Ideally, this information can be used to identify areas affected by nuisance weed growth, erosion, sedimentation and to locate pollution sources.

Ammonia Water Quality Characterization

The un-ionized form of ammonia is regulated in NJ Surface Water Quality Standards because it is harmful to fish and other aquatic life. In non-trout (NT) and Pinelands waters, the criterion is set at 50 parts per billion (ppb or ug/l) and in trout production (TP) and trout maintenance, the criterion is set at 20 ppb. Since un-ionized ammonia is considered a toxic compound, waters with more than 1 exceedence in 3 years are classified as "not meeting SWQS with respect to un-ionized ammonia".

Prior to upgrades and regionalization of sewage treatment plants, ammonia exceedences were common in streams receiving effluent. Between 1995 and 1997, 1247 un-ionized ammonia samples were collected in the ASMN and 1183 were compared to SWQS criterion. Of 1183 samples, 99.91% were below applicable SWQS criteria. One sample of 13 exceeded the 20 ppb UIA criterion in the Raritan River at Stanton Station. Thus, additional monitoring is needed to evaluate UIA at this location. This finding is consistent with decreasing trends in total ammonia associated with reduction in ammonia in effluent. Results are summarized on Table 3.1.3-4 below and provided for each station in Table A3.1.3-3 in the Appendix.

Table 3.1.3-4: Un-ionized Ammonia Characterization (1995-97)

UIA SWQS Status	# of Stations	% of Stations	# of Assessed River Miles	% of Assessed River Miles
SWQS Met	76	100%	176.4	100%
SWQS Met but Threatened	0	0%	0	0%
SWQS Partially Met	0	0%	0	0%
SWQS Not Met	0	0%	0	0%
Totals	76	100%	176.4	

The Raritan River at Stanton Station was not included on the 1998 Impaired Waterbodies List for UIA. Additional data and data assessments are needed to evaluate whether the conditions that contributed to exceedence are likely to re-occur; if so, listing will be pursued in the 2002 Impaired Waterbodies List. Based on the 1995 to 1997 data, trends through 1995 and a review of more recent data collected in the Redesigned ASMN, the Department expects to pursue delisting of most or all streams included on the 1998 Impaired Waterbodies List for un-ionized ammonia in the 2002 Impaired Waterbodies List.

Nitrate Water Quality Characterization

See the Drinking Water Designated Use Assessment in Part III, Section 3.4.

pH Water Quality Characterization

pH is a measure of the acidity of water. NJ SWQS include criteria for pH due to effects on aquatic life at pH measurements that are too basic (i.e., greater than 8.5) or too acidic (i.e., less than 5.5). Criteria for the naturally acidic Pinelands waters require pH between 3.5 and 5.5 pH units. Criteria for the Delaware River require pH between 6.0 and 8.5 pH units. Thus, criteria for pH require pH between a specified range and exceedences of the criteria can occur if pH is either too low or too high.

Between 1995 and 1997, 1216 pH measurements were collected in 76 stations in the ASMN and 203 (16.7%) of these exceeded the allowable range. Results for individual stations are depicted in Figure A3.1.3-3 and in Table A3.1.3-4 in the Appendix. Results are summarized below.

Table 3.1.3-5: pH Status (1995-97)

pH SWQS Status	# of Stations	% of Stations	# of Assessed River Miles	% of Assessed River Miles
SWQS Met	54	71.1%	114.4	64.9%
SWQS Met but Threatened	0	0%	0	0%
SWQS Partially Met	11	14.5%	34.1	19.3%
SWQS Not Met	11	14.5%	27.9	15.8%
Totals	76	100%	176.4	

Total Suspended Solids Water Quality Characterization
In order to protect aquatic life from excessive sedimentation, total suspended solids criteria were established in the NJ SWQS. Criteria for the Delaware River have not been established by DRBC.

Relatively few TSS samples were collected in the ASMN between 1995 and 1997. In order to accurately characterize TSS, this assessment was limited to the 8 stations, representing 9.2 miles, with at least 5 measurements during this time period. Of 8 stations with sufficient data, 5 stations representing 3.46 miles, exceeded the SWQS in less than 10% of samples, indicating SWQS were fully met with respect to TSS; 2 of 7 stations representing 3.31 miles partially met SWQS with respect to TSS because between 11% and 25% of measurements exceeded SWQS criteria; SWQS with respect to TSS were not met in 1 of 7 stations representing 2.43 miles because >25% of samples exceeded SWQS criteria. Additional data collection is needed to fully evaluate status with respect to TSS criteria. Results for individual stations are summarized in Table A3.1.3-4 in the Appendix.

3.1.4 Source and Cause Assessment for Water Quality

Dissolved Oxygen Source and Cause Assessment
Potential causes of exceedences of DO criteria were identified using water quality data, field observations and best professional judgement. This cause assessment is considered preliminary. Further assessments will be done to evaluate relationships between flow, nutrients, BOD and DO and to evaluate point and nonpoint source contributions to DO exceedences as TMDLs are planned, developed and implemented.

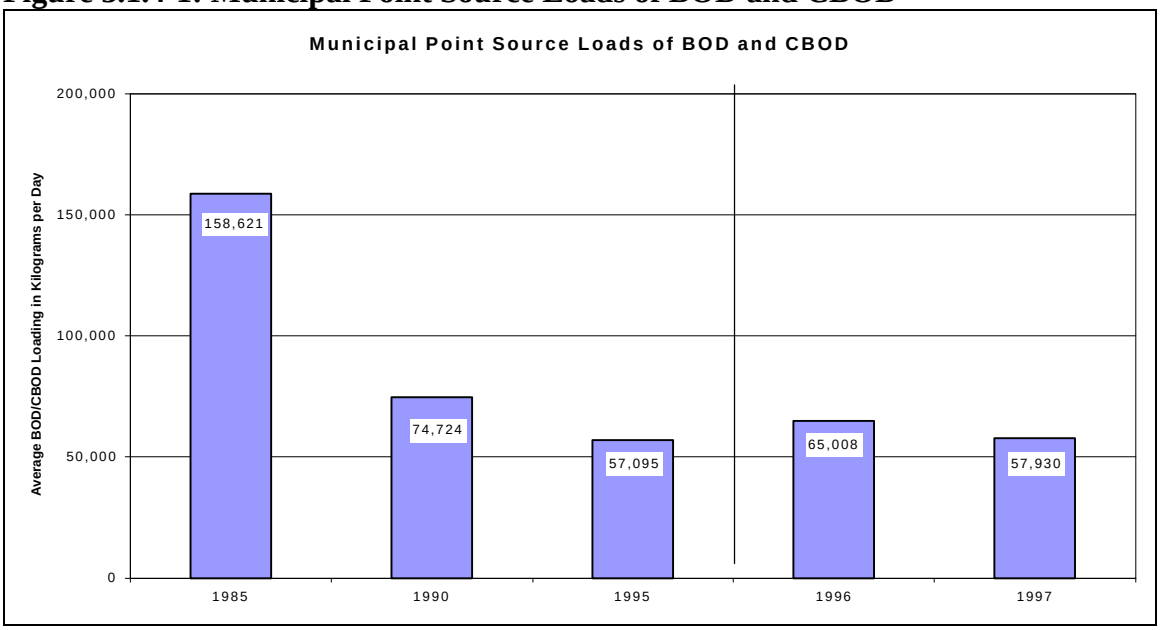
Table 3.1.4-1: Potential Causes of DO Exceedences- Preliminary Assessment

WMA	Station Number	Station Name	Potential Cause of DO Exceedences
6	01379000	Passaic R Nr Millington	Sluggish flow, swampy area; elevated nutrients from wetlands, wastewater treatment and nonpoint sources
19	01466500	McDonalds Br in Lebanon Forest	Significant ground water inputs with naturally low DO
6	01382000	Passaic R At Two Bridges	Sluggish flow due to water withdrawals; Elevated nutrients from wastewater treatment and nonpoint sources
15	01410784	Great Egg Harbor R Nr Sicklerville	Significant ground water inputs with naturally low DO
6	01381800	Whippany R Nr Pinebrook	Sluggish flow, swampy area; elevated nutrients from wetlands, wastewater treatment and nonpoint sources

Municipal Point Source Loads of BOD and CBOD Indicator: Biological Oxygen Demand (BOD) and Carbonaceous Biological Oxygen Demand (CBOD) indicate the amount of oxygen needed for biological degradation of organic materials in water and wastewater. Excessive BOD and CBOD loadings from point and nonpoint sources may reduce ambient dissolved oxygen

levels, stressing the aquatic community. As shown on Figure 3.1.4-1, municipal point source BOD and CBOD levels have decreased as a result of the Federal mandate for secondary treatment in 1988. As a result of improved wastewater treatment operations, BOD and CBOD loadings have been relatively stable since 1990, although the number of residents in sewered areas has increased. Additional detail is available from the NEPPS Environmental Indictor Technical Report. (NJDEP, 1997 and www.state.nj.us/dep/dsr).

Figure 3.1.4-1: Municipal Point Source Loads of BOD and CBOD



USGS evaluated 1998 in-stream BOD data from the Redesigned Ambient Stream Monitoring Network. Results from quarterly sampling were grouped by land use: background, forest, agricultural, urban. Results show that median levels for all land use types were below 2 mg/l BOD, however, in urban areas in-stream BOD sometimes exceeded 10 mg/l BOD. Point and nonpoint source contribution to these in-stream levels will be evaluated further through TMDL development.

Source Assessment for Exceedences of Total Phosphorus

As discussed in Section 3.1.1, elevated TP may contribute to excessive primary productivity in streams, lakes and reservoirs, Additional data and assessments are needed to evaluate whether excessive primary production is occurring and contributing to use impairments in streams. Eutrophic conditions have been found in 126 of 129 assessed public lakes.

Potential sources of nutrients(including TP) include domestic sewage effluent, municipal stormwater runoff, sediment flux, air deposition and contaminated groundwater. These sources were identified using water quality data, field observations and best professional judgement. This source assessment is considered preliminary. Further assessments will be done to evaluate relationships between flow, nutrients and primary productivity in rivers, lakes and reservoirs and

to evaluate point and nonpoint source contributions to TP exceedences as TMDLs are planned, developed and implemented.

Relative Contributions of Point and Non-Point Sources- Under contract to NJDEP, USGS conducted a study to evaluate the relative contributions of point and nonpoint sources of pollution to freshwater streams. (USGS, 1999) The study included a statistical evaluation of water quality data collected between 1976 and 1993 in the Ambient Stream Monitoring Network (ASMN) at 79 stations. Water quality data for 20 parameters collected under high and low flow conditions were used to indicate the relative contribution of constant sources (i.e., point sources and groundwater inflow) and intermittent sources (i.e., nonpoint and stormwater sources).

Relative contributions of point and nonpoint sources to total phosphorus concentrations from the USGS study indicate that point sources contribute relatively more total phosphorus at 15 locations (20%), nonpoint sources contribute relatively more total phosphorus at 12 locations (16%) and both point and nonpoint sources are important at 46 locations (63%). These results are shown on Figure A3.1.4-1 in the Appendix. The results of this study provide a general indication of relative contributions of point and nonpoint sources. However, additional assessment and modeling will be conducted to evaluate indicators of excessive primary productivity issues in the watersheds and to develop TMDLs as needed.

A preliminary assessment in WMA 2 indicated that the relative importance of point sources of TP has declined within that watershed management area and that nonpoint sources of TP should be carefully examined The inclusion of effluent limitations for phosphorus in some permits and the regionalization of other facilities have contributed to this decline. (NJDEP, 2000). Similar assessments will be conducted for the remaining watershed management areas. (See below).

As discussed in section 3.1.3, total phosphorus is a limiting nutrient in many freshwater systems and can contribute to excessive primary production (i.e., growth of aquatic algae and vegetation). In saline waters (i.e., salinity greater than 3 ppt), nitrogen is usually the limiting nutrient. Therefore, TP loads from point and non-point sources in estuarine and ocean waters are not likely to contribute to excessive primary productivity in coastal waters. Nitrogen loads to these waters may warrant additional investigation as a contributor to periodic low DO in the summer.

Contributions from Non-Point Sources- Nonpoint sources of pollution emanate from diffuse sources that are often dispersed and difficult to control. Nonpoint sources of pollution include municipal stormwater and contaminated runoff from construction, urban, suburban, agricultural lands, golf courses, waste disposal, contaminated sites, small septic systems, aquatic pesticide applications, sediment fluxes and air deposition. In New Jersey, municipal stormwater is categorized as a type of nonpoint source pollution even though it is discharged from a pipe because nonpoint sources pollute municipal stormwater. Additional data assessment is needed to characterize NPS loads of TP from various land uses, including consideration of nutrient cycling between water and bottom sediments in waters impaired by excessive primary productivity.

Elevated TP in Bottom Sediments- Between 1995 and 1997, streambed sediments were sampled once at 33 stations in the ASMN. The concentrations ranged from 40 parts per million (ppm) TP to 4,200 ppm TP; the average concentration was 510 ppm TP. TP in stream sediments is included in Table A3.1.3-2 in the Appendix and shown on Figure A3.1.4-1. Concentrations in sediments are significantly higher than those in the water column.

Future TP Assessment: An analysis of TP loads from regulated facilities, TP yields from land uses and sediment nutrient characterization is planned by NJDEP's Water Assessment Team. Data will be reviewed to evaluate the declining trends in phosphorus concentrations observed at 40 of the 79 stations in the ASMN. See Part III, Chapter 3.1.1 of this report. Results will be published and posted to the web.

TP Management Measures: Currently, NJDEP has included total phosphorus monitoring requirements or limits in NJPDES permits for 157 facilities that discharge treated effluent to freshwater rivers. In addition, the USDA is developing a policy to reduce or eliminate manure applications to farms based on TP concentrations in soils and TP needs of crops. The CREP program is expected to facilitate installation of buffer strips in 30,000 acres along agricultural stream corridors, further reducing TP runoff from agriculture. As TMDLs are planned and developed, areas with excessive primary productivity will be identified and targeted for management measures, including as appropriate, TP reduction strategies.

pH Source Assessment

pH measurements that are outside acceptable criteria ranges may occur because of natural conditions (e.g., naturally acidic soils) or due to runoff of liming agents and nutrients from fertilizer, failing septics and animal wastes. Additional assessments are needed to identify pH excursions attributable to natural conditions from those caused by pollution. Elevated pH measurements in the Pinelands Region, such as the Great Egg Harbor watershed, may be due to runoff of agricultural and lawn chemicals.

pH Management Measures: Areas that exhibit contravention of SWQS with respect to pH will be evaluated as TMDLs are planned and developed. The factors that contribute to these contraventions will be identified and managed according to the schedule developed in the TMDL MOA (See Appendix A2.5-1).

TSS Source Assessment

Elevated TSS may occur naturally in watersheds with highly erodable soils. Elevated TSS may also be caused by stream bank and streambed erosion and runoff due to land disturbance, stormwater discharges and other flow-related conditions. Additional assessments are needed to evaluate potential causes of elevated TSS in the 3 locations identified in this assessment (Raritan River at Queens Bridge, Stony Brook at Princeton and Neshanic River at Reaville).

TSS Management Measures: Areas that exhibit contraventions of SWQS with respect to TSS will be evaluated as TMDLs are planned and developed. The factors that contribute to these

contraventions will be identified and managed according to the schedule developed in the TMDL MOA (See Appendix A2.5-1).